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MOLECULES[1]

By Professor N. V. SIDGWICK
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IT is commonly assumed that chemistry, like physics, can prevail everywhere, but on inquiry it can be readily seen that this is by no means so; it is only under rather exceptional conditions that chemical processes can occur. This is a matter which concerns every one, and not chemists alone, because it is only where chemistry is possible that life is possible. Indeed, that is one reason why the limitations of chemistry have not always been recognized, because we are enclosed within the same limits ourselves.

Chemistry is commonly called molecular physics: it is the investigation of the structure and behavior of those little groups of atoms which we call molecules, whose almost infinite repetition constitutes the chemical substances of our ordinary experience. The first point therefore is to know what molecules are, and in general terms why they are formed.

[1] The Maiben Lecture delivered before the meeting of the American Association for the Advancement of Science, Denver, June 23, 1937.

The matter of the universe consists of atoms, of some 90 to 95 different elements. Each atom is made up of a small positively charged nucleus, surrounded by a number of electrons equal to the number of units of positive charge on the nucleus. Now the electrons surrounding a nucleus can arrange themselves in groups of greater or less stability, and it often happens that two or more atoms can make a more stable arrangement of their electrons by pooling them or by transferring some of them from one atom to the other. If the extra stability so gained is great enough, the atoms will remain attached to one another, and a molecule will have been formed. It is only a few of the outermost electrons of any atom which take part in these rearrangements—the greater number are already sorted out into groups—and in consequence the number of atoms which forms a molecule is never large, often only two or three, and rarely more than a hundred.

It is the business of chemists to examine the behavior, both physical and chemical, of molecules, to determine with the help of the physicists their structures, and to find the relations between the structures and the properties.

If this is so, the first thing that is obvious is that chemistry can only occur where there are molecules, and that chemical processes can only occur where these molecules react with one another. This imposes definite limits on the sphere of chemistry, limits which in a sense are surprisingly narrow. We can arrive at an idea of these limits in two ways, either by direct observation or by deduction from the general principles of physics; as I hope to be able to show, the results of these two methods agree. For the observational method we have to rely on astronomy, except so far as this globe is concerned. The progress of that science during the last hundred years has shown that the composition of the matter in all parts of the universe is much the same, that the stars are made up of the elements which we know on earth, and that the same laws of nature hold elsewhere as we find here. Thus we can apply our knowledge of the behavior of matter on the earth to other parts of the universe with a fair prospect of success.

The most obvious characteristic in which different stars differ is their temperature. The heat of a body is due to the agitation of its molecules, and the energy of this agitation is proportional to the temperature. Throughout the universe the temperature varies widely, from a very few—say two or three—degrees above the absolute zero in empty space, or in very old or very small stars such as the moon, up to several millions (even hundreds of millions according to some physicists) of degrees in the center of large stars like the sun.

Our knowledge of the composition of the stars (and much of our knowledge of their temperatures, too) is derived from the study of their spectra; every element or compound has a characteristic spectrum, and from either the light emitted by a star or that absorbed when light from another source passes through its atmosphere, we can discover the nature of the substances composing that atmosphere. The story of the way in which these problems have been solved is a most fascinating one, but it would take too long to discuss it here; on the molecular side the fundamental work is largely due to Rupert Wildt in Germany, but much of the conclusions have been worked out by Professor H. N. Russell, of Princeton, who has described them in his Halley Lecture (Oxford, 1933) and more especially in the address which he gave at Pittsburgh as the retiring president of this Association.[2]

[2] Printed in *Nature*, 135: 219, 1935; SCIENCE, 81: 1–9, 1935.

From these investigations it appears that in the sun's atmosphere with a temperature in the parts we can see of about 6,000° Abs., there are practically no molecules at all; even those which are most stable at high temperatures, such as the cyanogen radical CN, can scarcely be detected. We may therefore take this temperature of 6,000° Abs. as being the highest temperature at which chemistry can exist. This is nearly twice the temperature of the electric arc, which is the highest temperature that we can produce artificially in any considerable space. At any temperature lower than this we shall find molecules existing wherever there is matter.

But at these low temperatures, say at the boiling point of liquid air—180° C. or 100° Abs.—though there must be plenty of molecules, there will be very little chemistry. Chemistry implies not only the existence but also the reactions and interconversions of molecules, and we can show that at such low temperatures the great majority of molecules do not react.

It is therefore evident from our observation of the behavior of matter that the scope of chemistry in the universe is strictly limited; it can exist only where it is neither too hot nor too cold. Moreover, these limits are fairly narrow. The temperature of different parts of the world varies, as we have seen, from about 2° Abs. in interstellar space to at least 40 million and perhaps as much as 1,000 million in the centers of some stars, that is, in the ratio of 20 millions, or perhaps 500 millions, to one, or, in the terminology of the musical scale, over 24 octaves on the lower estimate and 30 octaves on the higher. The range over which we may consider chemical reaction to be possible to any considerable extent is from 100° Abs., the boiling point of liquid air, to 6,000°, the temperature of the outer layers of the sun's atmosphere, and this is a ratio of 60:1, or less than 6 octaves—say from a quarter to a fifth of the whole scale.

It is thus clear that the phenomena of chemistry are not universally diffused; they are confined to particular parts of the world where it is neither too hot for molecules to exist nor too cold for them to react. If these considerations merely defined the province of the chemist, we might say that they were of small interest to any but chemists; but they go much further than this. It is quite clear that without chemistry there can be no life. Even the simplest of living organisms are made up of molecules of great complexity, and their life depends on the occurrence of chemical changes among these molecules. Living organisms can endure very diverse conditions, but the limits between which molecules can exist and react are final. It is only within them that life can be carried on.

As these limits are so important, it is worth while to examine them rather more closely, and inquire what

is the reason for their existence—why molecules are all destroyed above 6,000° and cease for practical purposes to react below 100°. The temperature, which is the decisive factor, is a measure of the agitation of the molecules; these are always in motion, and their energy, as measured in calories per gram-molecule, is almost exactly twice the average temperature. Hence the mean energy of thermal agitation of the molecules is 200 cals. at 100° Abs., and 12,000 cals. at 6,000°. But though this is the average energy, the energies of the individual molecules vary over a wide—theoretically an infinitely wide—range around this mean, the number that have any given energy being less, the more that energy departs from the mean. For example, the fraction of the molecules of a gas which have energies at least x times the mean will be $1/N$, where x and N have the values given in Table I.

TABLE I

DISTRIBUTION OF ENERGY IN A GAS. ONE MOLECULE IN N HAS AT LEAST x TIMES THE AVERAGE ENERGY

$x =$	$N =$
2	$7 \cdot 4$
3	$20 \cdot 1$
5	$148 \cdot 6$
10	27,120
20	$4 \cdot 9 \times 10^{8}$
30	$1 \cdot 1 \times 10^{13}$
50	$5 \cdot 3 \times 10^{21}$
100	$2 \cdot 7 \times 10^{43}$

Incidentally it follows from this that in a liter of gas at the ordinary temperature and pressure there are about 5 separate molecules with 50 times the average energy, and that one molecule with 100 times the average energy occurs in it for one second in every 38 million million years.

Now it is obvious that there will be an end to the existence of any pair of molecules when they hit one another so hard as to break one another up, and this is essentially the reason why, as we have seen, they cease to exist at high temperatures. The amount of molecules present depends on the relative chances of their being formed and broken up, which is rather a complicated question; but we shall get an idea of their length of life if we consider how often at any given temperature a molecule will be struck with sufficient energy to disrupt it. The average energy required to break a link between two atoms (it does not vary very widely) is 70,000 calories per gram-molecule. The total number of collisions which a molecule of a gas or a liquid suffers in a second is very large; it varies with the mass, pressure and temperature; but for a molecule of air at the ordinary temperature and pressure it is $1 \cdot 2 \times 10^{9}$ per second. In a gas like air at 1 atmosphere we can calculate for any given temperature what is the total number of collisions that a molecule undergoes per second, and how many of these are violent enough to break it up. The answer is given in Table II, in which the successive columns give the absolute temperature, the number of collisions per second for air at that temperature, the number of effective collisions (*i.e.*, of energy at least 70,000 calories per gr. mol.), and finally, for the lower temperatures, the reciprocal of this last figure, the time before an effective collision occurs.

TABLE II

COLLISIONS IN AIR AT 1 ATMOSPHERE

T° Abs.	Collisions per sec.		1 Effective collision in
	Total	Effective	
500°	$1 \cdot 5.10^{9}$	$5 \cdot 9.10^{-22}$	$3 \cdot 7.10^{9}$ years.
1,000°	$2 \cdot 1$ "	$1 \cdot 3.10^{-4}$	16 hours.
2,000°	$2 \cdot 9$ "	73	1/73 sec.
3,000°	$3 \cdot 6$ "	29,800	
4,000°	$4 \cdot 1$ "	726,000	
5,000°	$4 \cdot 6$ "	4,210,000	
6,000°	$5 \cdot 1$ "	13,600,000	

It is clear from these figures why molecules tend to disappear as the temperature gets higher, and why at that of the sun's atmosphere they have practically ceased to exist.

Having seen that we get a satisfactory agreement between observation and calculation for the highest temperatures at which molecules can exist, we can now go to the other extreme and consider what is the lowest chemical level of temperature, that at which the reactions of molecules are so slow that they practically do not occur. It must be understood that we are now considering not merely destructive reactions involving the breaking up of a molecule, as we were before, but reactions in general, in which molecules combine with one another or take up or lose or exchange atoms.

This needs a little preliminary consideration of the conditions of chemical reaction in general. It is clear from what I have said about the frequency of collisions between molecules that any reaction in which two molecules always reacted when they met would be practically instantaneous: in other words, any chemical reaction which is slow enough to be measured must be one in which only a very few of the collisions cause reaction to occur. In our previous problem, which was concerned with reactions in which an atomic linkage was destroyed, it was easy to see that only the more energetic collisions would count; but we are now dealing with reactions in general, where there need not be any energy absorbed, but on the contrary energy may be evolved. Even here, if the rate of reaction is not too quick to measure, we can see that only a small proportion of the hits can cause chemical change. There must then be some difference in character between a collision which is fruitful, that is, which leads to reaction, and another collision which is not. This is obviously the difference in energy which we have already discussed. Before two colliding molecules can react they must have a certain amount

of energy, which in all but very rapid reactions is much more than the normal molecule has, and is an amount that only very few of the molecules possess. The actual amount of this energy, which is known as the heat of activation, varies greatly, but its average value for the ordinary slow reactions is of the order of 30,000 cals. per gr. mol., which is not very different from that necessary to disrupt the ordinary link (70,000 cals. on the average), and so this line of argument leads to the same general conclusions as we have already reached. But from the further consideration of the process of reaction we get some interesting results. When two molecules react, as in

$$A_2 + B_2 = 2\,AB,$$

we have two changes occurring: the relative positions of the atoms change, and also the orbits of their electrons. When it was first realized that the linking of atoms in molecules is effected by means of the electrons, it was very naturally thought that the important process in the reaction, and the one for which the activation energy was needed, was this rearrangement of the orbits of these electrons. Further work has, however, shown that this is not so: the electronic rearrangements take place relatively easily as soon as the atomic nuclei have been brought into the proper positions, and it is for this latter purpose that the activation energy is mainly required. At first sight this movement of the atoms seems as if it should be easy. We commonly represent the atoms in a molecule by spheres in contact, and this gives us for this reaction the picture from which it would appear that

FIG. 1

the reaction should occur whenever two molecules met. This picture is, however, imperfect in a very important respect. We now know a great deal about the shapes and sizes of molecules, and one essential fact that we have learned is that the distance between two atoms linked together in the same molecule is very much shorter than that between the same two atoms when they are not linked, as when they are in different molecules, even when the molecules come as close to one another as they can. Taking the lighter atoms, with which in organic chemistry, and especially in biochemistry, we are mainly concerned, we may say that the average distance between two linked atoms is about $1 \cdot 5$ Ångström units (1 Å.U. $= 10^{-8}$ cm), while that between two neighboring but not linked atoms is about $3 \cdot 5$ Å.U.—more than twice as great. The difference is due to the fact that two unattached atoms repel one another because their outsides are formed of negatively charged electrons, but when these atoms are chemically linked this repulsion is overcome. If we use for our models, as I did just now, little spheres which are in contact when the atoms are linked, we may express this other effect by supposing that every atom on the unlinked side is surrounded by a sort of envelope about 1 Å.U. thick, separating it from other molecules. It is then clear why it is usually necessary for a molecule to have considerable energy before it can react: it must be able to penetrate this envelope, and get near enough to the other molecule for the new atomic linkage to be established.

This question of the existence of molecular envelopes and of heats of activation may seem to be of a rather unpractical kind or, as people outside universities say, of merely academic interest. But its interest is in fact extremely practical. These envelopes are of far greater importance to us than anything that courts or kings—or even Presidents—can cause or cure. We are all made up of compounds of carbon, hydrogen, oxygen and nitrogen, with a small amount of other elements. Now a system made up of these elements, if it has plenty of free oxygen, as we have in the air, when it has finished reacting is practically all converted into water, carbon dioxide and nitrogen. The only thing that prevents us from changing at once into these products is that the rate of reaction is slow, and we are able to repair the damage as fast as it occurs. But this slowness of reaction is due to the existence round our molecules of this molecular envelope. If that were removed the oxygen molecules would come up into position for reaction alongside of the organic molecules at every collision: every collision, and not merely as at present a few of the more energetic, would lead to oxidation, and we should all be burned up in a few moments.

This brings me to another question, that of the conditions under which life is possible. We have seen that it is only possible where there are molecules and where there is chemical change, and I have tried to show what the temperature limits of the occurrence of chemical change are. But it is evident that the conditions under which life as we know it is possible are much narrower than these. The complicated molecules which form the basis of living tissue can not exist up to 6,000° or react down to 100° Abs. A complicated molecule is always more easily destroyed than a simple one, because if it gets broken the parts are less likely to come together again.

But if we really want to know under what conditions life can exist, we must not pay too much attention to the forms of life which we know on earth, but must consider whether other forms of life may be possible, and whether there may be other conditions

under which life can develop. As far as we can see, the existence in any material form of life, including in that term animals, that is, organisms which can move about freely (I don't think we are much interested in purely vegetable existences) requires four things: (1) organized living matter; (2) an external source of energy; (3) some unorganized and probably inorganic substance in the surroundings which can react with the living matter and give it the necessary energy; and (4) what I may call a lubricant, some probably inorganic substance liquid at the temperature of the animals, which makes their motions and their reactions possible. We may consider these four factors separately.

(1) *The organized living matter.* The material basis of all the forms of living matter that we know is a series of compounds of carbon. That is why the chemistry of carbon is known as organic chemistry. We have first to consider whether there is any other element that might take the place of carbon. There is only one that has ever been suggested as possibly capable of replacing carbon in living matter, and that is silicon. It has however been evident for some time that even silicon has not the properties which such an element needs. This makes our inquiry more precise, because we know something about the range of stability of carbon compounds, and the possibility of some entirely different material being employed is excluded.

(2) *The external source of energy.* If our animals are to do anything, they must acquire energy from somewhere. How this is done on the earth is familiar to all of us. The ultimate source of the energy is the sun's radiation, which enables plants to build up compounds of carbon from water and the carbon dioxide of the atmosphere; these compounds are eaten by animals, and in their bodies combine with the oxygen of the air, being reconverted into water and carbon dioxide and in the process liberating energy for the use of the animals. It is difficult to see what other method there can be which is anything like as convenient. The animals must have some external source of energy. Any chemical source, from the chemical combination of the unorganized world surrounding them, would very soon be used up, and the only steady source of supply we can imagine is the radiation from a star. If this is to be used, the living organism which is to absorb and transform it must have a very large surface in comparison with its mass. These are very unsuitable proportions for a creature that is to move about freely, which should be compact. Hence it is an obvious economy to separate the two functions: to have one kind of machine, which need not move about, with a large surface to absorb the radiant energy, and another which is adapted for motion but not for the absorption of radiant energy and which gets its energy by consuming the products of the first kind and reconverting them into the material of lower energy from which they were formed by the help of the radiation. The source of radiant energy will be the radiation from a hot star, which implies that the life must be confined in the main to the outside of the planet on which it occurs, and also that there must be in its neighborhood a hot star big enough and hot enough to supply the necessary radiation. This will normally be the star to whose system the planet belongs.

(3) *The energy-carrier.* The animal must have access to some substance which can combine with the product of the plant with the liberation of energy. It is difficult to think of anything which could replace oxygen for this purpose. It must be a substance which can exist in the gaseous or liquid surroundings of the organism and will not all combine with the solids. The only materials which meet these requirements are the gaseous elements and their volatile compounds, and the latter, such as water or ammonia, have not enough energy for the purpose. We are thus confined to oxygen, for nitrogen is far too inert.

(4) *The lubricant.* It is fairly obvious that life can not be carried on by creatures entirely composed of dry solids. Chemical reactions scarcely occur in solids, and as we all know mechanical operations are impossible without a lubricant. Hence the world where life is to be possible must contain a liquid which can interpenetrate the living matter. We can further see that the substance must be one which is liquid at the temperature of our living system, that is at temperatures which are not too high for the complicated organic compounds of living matter to exist. Practically the only common substances which will satisfy all these requirements are the lower hydrocarbons like methane and ethane, ammonia and water. The hydrocarbons are much too inactive; the atmosphere in which our animals live must contain oxygen, and this would rapidly burn up the ammonia to nitrogen and water. Hence the only available liquid which will support the activities of living creatures is water. So, the temperature limits of life on earth must be valid for life of any kind anywhere; the temperature must lie between limits which are only slightly outside the melting and boiling points of water.

To sum up, it would seem that life will be mainly confined to the surface of the planet on which it occurs, owing to the necessity of its receiving radiant energy. This planet must not be too small or the atmosphere will be lost, as has happened on the moon. On the other hand, it must not be too large: if its atmosphere is too dense, the radiation from which the life derives its energy will be cut off by the upper layers, and not enough will reach the surface, where practically all the living organisms must be. The

prevalent temperature must be on the average between the boiling and the freezing point of water, though a slight excess or defect beyond these limits is possible. This is of course the most serious limitation of all. The freezing point of water is 273° Abs.; the boiling point depends on the atmospheric pressure, but as we must not have too dense an atmosphere we shall be safe if we say that the boiling point will not lie above 500° Abs. (227° C.), which is its value under 27 atmospheres pressure. This gives us a temperature range of only 500–300 or less than one octave out of the 24 or 30 octaves that occur in nature.

The application of these conclusions to the universe is a matter for the astronomers. The conclusions are not of course confined to the solar system, though there is a difficulty in applying them anywhere else, since all the stars that we can see are too hot, and life could only occur on their planets, which are too small to be visible. As far as the familiar planets of our own system are concerned, they only confirm the views that have long been held. The moon is much too small for life to be possible; Mercury is probably too small and too hot; Jupiter and the outer planets are too cold. The only places in the solar system where life is possible seem to be the earth and our two neighbors, Mars and Venus.

OBITUARY

FREDERIC E. IVES

FREDERIC EUGENE IVES, inventor, investigator, scientist, died on May 27, 1937, at his home in Philadelphia. His achievements were many and important, and were all the more remarkable in that he was essentially a self-educated man; he never attended a formal school after he was twelve years of age.

He was born on February 17, 1856, on a farm near Litchfield, Connecticut. His parents were descendants of the early New England settlers. From his father, Hubert Leverit Ives, a hard-working farmer, he inherited a capacity for concentrated application to which may be credited much of his success; from his mother, Ellen Amelia Beach, he derived a love of the artistic which doubtless stimulated his interest in the field of investigation which he chose for his own.

When he was twelve his father died, which interrupted his schooling and forced him to earn his living. After a brief and unsatisfactory experience as clerk in a country store he became apprentice in the printing office of the *Litchfield Enquirer*. The years spent in this newspaper office formed an excellent substitute for the schooling which he had missed and also gave him valuable training in preparation for his future career.

At this time he became interested in picture making both by the process of wood engraving and the art of photography. The limitations of the former method impressed him with the advantage of the photographic process and led him later to attack the problem of photo-engraving. His spare time, which was little, was spent in experiments in photography, his first camera being made, as he tells us, of a cigar box and a spectacle lens.

After completing his apprenticeship he worked for some time as a printer but soon turned to photography as his vocation. This led to his employment in 1874 by Cornell University, where he remained for four years in charge of the photographic laboratory. His contact with this institution doubtless stimulated his interest in the scientific aspect of his work and inspired his inventive genius. It is to these years that we refer his first notable achievement, the invention and the development of the first commercially successful half-tone process of photo-engraving.

The success of this invention, which has revolutionized the art of illustration, led him to connect himself with a printing establishment in Philadelphia in which he worked as a photo-engraver, maintaining at his home a private laboratory where he busied himself incessantly in numerous investigations which many times led to important inventions. Here in 1886 he developed the cross-line screen method of half-tone reproduction which is now universally used, superseding his earlier process. Here also he carried out the extensive experiments in color photography and color reproduction by the trichromatic process. His brilliant success in the solution of this problem by the invention in 1892 of the photochromoscope, or, as he called it, Kromskop, won for him recognition in the scientific world. This was perhaps his greatest achievement, and one in which he continued to work throughout his life, developing improved methods and new applications; as for instance to the moving picture industry, where the colored films shown at the present time are largely due to his inventions.

In addition to these accomplishments the work of Ives bore fruit in many other ways. Numerous devices, mostly in the field of optics, are due to his ingenuity. Among these may be mentioned an improvement in the binocular microscope, the parallax stereogram, diffraction grating replicas, a diffraction photochromoscope and a trichromatic colorimeter. Over seventy patents were taken out for his inventions, and as many more could easily have been obtained.

With exception of a few years in London and in New York spent in exploiting his inventions, the remainder of his life was passed in Philadelphia. He

was an active member of the Franklin Institute for over fifty years and frequently reported his investigations before that body. He was also a member of the American Philosophical Society and of many other scientific organizations.

While a number of medals were awarded him for his inventions and while his work was appreciated by those who were best able to judge, still it did not receive in his lifetime the recognition which it deserved. After his death the city in which he had dwelt so long made partial amends. The 22d of July, 1937, was designated officially as "Ives Day," and a public tribute was paid to him at the Franklin Institute at which the pioneer nature of his inventions on half-tone and color photo-engraving was appropriately commemorated. On this occasion the son of the inventor, Herbert E. Ives, of the Bell Telephone Laboratories, presented to the institute the original patent in color photography and other memorials of his father.

The chief characteristic of Ives's method of work is that it was firmly based on true scientific principles and not upon a haphazard seeking for results. His cross-line half-tone process was worked out with a thorough understanding of the optical principles involved in lens aperture, line spacing, etc. Again his work in color reproduction shows a complete grasp of the trichromatic theory of Young, Helmholtz and Maxwell which was completely lacking with most of the other experimenters in this field; with the result that all subsequent work in color printing and color photography is based upon his fundamental investigations. Moreover, he possessed the skill of utilizing these scientific principles to obtain practical results with the maximum of simplicity. In consequence, much of his work has a completeness and one might say an artistic quality which left little room for improvement by his successors.

Unfortunately he did not reap the proper material reward for his ingenuity. Some of his inventions (notably his half-tone process) were unprotected by patents. Others were the subject of costly litigation or were infringed upon by his competitors. Fortunately for himself and for the world he was a type of man who—to use his own words—"will pursue his course through any amount of poverty and hardship and indifference, thinking much more about his work than about any material reward which it may bring." And he closes his autobiography with the words "I am thankful that I could find contentment in the pleasure of accomplishment."

HORACE C. RICHARDS
RANDAL MORGAN LABORATORY OF PHYSICS,
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RECENT DEATHS

DR. MELVIN E. HAGGERTY, dean of the education department of the University of Minnesota, president of the National Association of College Teachers and an authority on educational psychology, died on October 6. He was sixty-one years old.

DR. WILLIAM KELLY, mining engineer, of Iron Mountain, Mich., past president of the American Institute of Mining and Metallurgical Engineers, died on October 1 at the age of eighty-three years.

DR. NATHAN WINSLOW, professor of clinical surgery at the School of Medicine of the University of Maryland for thirty-four years, died on October 7 from injuries suffered in an automobile accident.

LEON HOWARD WORTHLEY, of Montclair, N. J., principal administrator of the division of Japanese beetle control and Dutch elm disease eradication of the Bureau of Entomology and Plant Quarantine of the U. S. Department of Agriculture, died on October 9 at the age of sixty years.

EDWARD B. FITTS, professor of dairy husbandry at the Pennsylvania State College, died on September 27. He was sixty-six years old.

DR. LOUIS NAPOLEON DELORE, for forty-nine years professor of anatomy in the University of Montreal, died on October 3. He was seventy-five years old.

PROFESSOR ADOLF L. F. LEHMANN, from 1909 to 1930 professor of chemistry in the University of Alberta, died on September 27, aged seventy-three years.

DR. DE BURGH BIRCH, emeritus professor of physiology at the University of Leeds, died on September 18 at the age of eighty-five years.

DR. ST. CLAIR SYMMERS, from 1904 until his retirement in 1930 with the title emeritus Queens professor of pathology at Queens University, Belfast, died on October 4 at the age of seventy-four years.

DR. RICHARD VON HERTWIG, professor emeritus of zoology and comparative anatomy at the University of Munich, died on October 4 at the age of eighty-seven years.

SCIENTIFIC EVENTS

THE AUSTRALASIAN COLLEGE OF PHYSICIANS

ACCORDING to *The British Medical Journal* the Australasian College of Physicians, which now comes into existence, has been planned to some extent on the pattern of the Royal College of Physicians of London, with variations to suit the needs of a community whose professional schools and leaders are scattered sparsely through a large continent where means of communication are not yet fully developed. The *Journal* states

that in the new college the proportion of fellows from each state to sit on the council will be arranged in advance so as to make its governing body geographically balanced. The president will be elected by the council and not, as in London, by a committee of all the fellows; and the members of the college will have representation on the council. The assumption of responsibility for a qualifying examination is not contemplated: the college will have no licentiates. Its two grades will be that of membership, conferred by a board of censors after examination, or, as in England, on published work; and that of fellowship, awarded to those chosen by the council year by year from among the members of more than four years' standing. Foundation fellows will include all those recognized as teachers of medicine by the medical faculties of the universities of Australia and of New Zealand. The college will absorb the Association of Physicians of Australasia, whose members will become foundation fellows. It will carry on the work of that association, including the organization of an annual meeting at different centers at which scientific communications are submitted. In drawing up its constitution the new college has taken full advantage of information put at its disposal by the Royal College of Physicians of London, which last winter appointed Sir Edmund Spriggs as an emissary. His visit to Australia was followed by one to England from Sir Charles Blackburn, Sydney; Dr. S. V. Sewell, Melbourne; Dr. L. S. Latham, Melbourne; Dr. A. W. Holmes à Court, Sydney, and Dr. E. B. Gunson, Auckland, who conferred with Lord Dawson of Penn and other colleagues at Pall Mall East. Apart from the promotion of research in clinical medicine and the dissemination of knowledge, the Australasian College will serve as a meeting point for physicians and provide opportunities for discussion and common action when legislative or other measures affecting the national health arise. The first president is Sir Charles Blackburn, consulting physician to the Royal Prince Alfred Hospital, Sydney, and the first vice-president is Dr. S. V. Sewell, physician to the Melbourne Hospital.

THE GEORGETOWN UNIVERSITY BRAIN RESEARCH INSTITUTE

ON September 10 the School of Medicine of Georgetown University, Washington, D. C., established an institute for the investigative study of the brain to be known as the Georgetown University Brain Research Institute. It will be under the direction of Dr. Othmar Solnitzky, professor of anatomy, with Dr. Francis J. Warner as assistant director.

A comprehensive program of neurological research work will be launched along the four following directions:

1. A complete study of the brains of vertebrates from the cyclostomes to the primates.
2. A thorough study of the development of the human brain with special regard to its morphology, nuclear masses and fiber tracts.
3. Experimental study of the function of the various nuclei and fiber tracts of the brain by means of Marchi degeneration and retrograde cell degeneration.
4. A comprehensive study of the neuropathology of the human brain.

The institute already possesses a large collection of animal and human brains, many of which are sectioned and stained. The instrumentarium will include, among others, the Horsley-Clarke stereotaxic instrument, the Vogt-Sartorius brain microtome, celloidin and paraffin microtomes, a specially constructed brain macrotome, cold electric cautery, moving picture camera, microphotographic camera and dissection microscopes. It will also have two full-time specially-trained technicians, a photographer and an artist. A large library of books, monographs and reprints covering every phase of the projected research is available. A modern and well-equipped animal experimental laboratory is being built.

The facilities of the institute will be made available to those interested in any phase of brain research. Individual desks and microscopes will be placed at the disposal of investigators.

Contributions of animal and human brains, both normal and pathological, as well as reprints of all neurological publications, will be gratefully accepted and duly accredited.

MELLON INSTITUTE TECHNOCHEMICAL LECTURES

A SERIES of lectures on important subjects in industrial chemistry and chemical engineering will be presented by research specialists of Mellon Institute during 1937–1938. These discourses, which will be delivered on Thursdays, in the fourth period (11:30 A. M.–12:30 P. M.), throughout both semesters, in the auditorium of the institute, will be open to all students of industrial chemistry and chemical engineering in the University of Pittsburgh, as well as to members of the institute.

October 14, Dr. E. R. Weidlein, "Chemical Engineering in the Industries."

October 21, Mr. S. M. Phelps, "Refractories Technology."

November 4, Mr. R. H. Heilman, "Heat Insulation."

December 2, Dr. J. L. Young, "Advances in Ferrous Metallurgy."

December 16, Dr. G. H. Young, "Corrosion Problems."

January 13, Dr. F. W. Adams, "The Heavy Chemical Industry."

February 17, Dr. E. P. Barrett, "Bone Products."

March 3, Dr. L. W. Bass, "Food Technology."

March 17, Dr. W. B. Burnett, "New Textile Products."
March 31, Dr. R. L. Wakeman, "Synthetic Resins."
April 14, Mr. D. E. Pearsall, "The Explosives Industry."
April 28, Mr. E. R. Mease, "Organic Chemical Processing."
May 12, Dr. E. B. Kester, "Coal Products."

SYMPOSIUM ON BIOPHYSICS OF THE AMERICAN INSTITUTE OF PHYSICS

A SPECIAL meeting devoted to the subject of biophysics will be held on November 4, 5 and 6 under the auspices of the American Institute of Physics. The Eldridge Reeves Johnson Foundation for Medical Physics of the University of Pennsylvania is cooperating in arranging the meeting and will act as host. All sessions will be held in Philadelphia at the university.

On certain evenings during and after the meeting Dr. Irving Langmuir will present a series of lectures under the Johnson Foundation Lectureship. The subject of the lectures will be "Monolayers and Multilayers and their Applications to Biological Problems."

The names and tentative subjects of some of those expected to address the morning and afternoon sessions are as follows:

William Mansfield Clark, professor of physiological chemistry, the Johns Hopkins Medical School, "Potential Energies of Biologically Important Oxidation-Reduction Processes."

Wallace O. Fenn, professor of physiology, University of Rochester, "The Mechanics of Muscular Contractions."

Herbert S. Gasser, director, the Rockefeller Institute for Medical Research, "Electrical Signs of Biological Activity."

L. H. Germer, research physicist, Bell Telephone Laboratories, Inc., "Electron Diffraction Methods of Studying Organic Films."

E. Newton Harvey, professor of physiology, Princeton University, "The Physical Properties of Protoplasm."

Selig Hecht, professor of biophysics, Columbia University, "The Photochemical Basis of Vision."

M. H. Jacobs, professor of general physiology, University of Pennsylvania, and director, the Marine Biological Laboratory at Woods Hole, "Diffusion Processes in Living Systems."

Francis O. Schmitt, associate professor of zoology, Washington University, "Optical Studies of Living Systems."

D. W. Bronk, professor of biophysics, University of Pennsylvania; director, the Johnson Foundation for Medical Physics, "The Relation of the Biological and Physical Sciences."

Additional papers have been invited on nuclear physics as a tool for biological research, the pathological effects of radiation, energy exchanges in living systems and other biophysical subjects.

As a part of the meeting, the last day, Saturday, November 6, will be devoted to contributed papers and general discussion. Workers in the field are invited to contribute ten-minute papers on the subjects of their researches. They are requested to submit abstracts not exceeding 200 words in length, not later than October 25 to insure a place in the final program.

A further announcement of the meeting will be mailed to any one interested in receiving it. There will be no general circularization of notices. Admission cards will be necessary for some of the sessions. The institute and the foundation are anxious to welcome any one interested in the subject of the conference and will gladly mail information and admission cards upon request, addressed to American Institute of Physics, 175 Fifth Avenue, New York, N. Y.

THE ANNUAL MEETING OF THE AMERICAN WELDING SOCIETY

THE eighteenth annual meeting of the American Welding Society will open at Atlantic City on October 16 and continue through Friday, the 22d. A metals exposition in which nearly fifty organizations are participating will be held. The American Society of Mechanical Engineers will join in sponsoring a technical session on Tuesday afternoon.

At the opening session at the Hotel Traymore on Monday morning, Alfred E. Gibson, vice-president of the Welman Engineering Company, Cleveland, Ohio, will deliver the annual presidential address. E. R. Fish, of the Hartford Steam Boiler and Insurance Company, senior vice-president of the society, will preside. The Samuel Wylie Miller Memorial Medal "for meritorious achievement contributing conspicuously to the advancement of the art of welding and cutting" and the Lincoln Medal "for the best paper of the year in the *Welding Journal*" will be awarded and the election of new officers will be announced.

Comfort A. Adams, formerly Gordon McKay professor of electrical engineering at Harvard University, will present a report of progress in the Welding Research Committee of the Engineering Foundation of which he is chairman. This committee, organized in 1935, is sponsoring more than fifty active research projects in universities of the United States and Canada; assembling, digesting and publishing the world's available information regarding welding research; and correlating current and future programs in industrial and fundamental research in welding.

Reviews of welding activities will be made by the regional vice-presidents of the society and there will be a series of eight technical sessions, describing recent advances in welding. "Fundamental Research in Welding" will be the subject of an all-day symposium

on Tuesday, at which the investigations of eight laboratories will be reported. The American Society of Mechanical Engineers will join in another technical session in the afternoon, at which G. F. Nordenholt, of the Product Engineering Company, New York, will be chairman. H. M. Hobart, consulting engineer of the General Electric Company, who received the Samuel Wylie Miller Memorial Medal last year, will preside at a conference and meeting of the fundamental research committee on Tuesday evening. Four papers devoted to "Fabrication" will be given on Wednesday morning. The afternoon will be spent in viewing the Metals Exposition. The growing demand for stainless steel and its applications and the welding of low alloy steels will be outlined at the Thursday morning symposium and there will be a shipbuilding symposium on Thursday afternoon. The final session on Friday morning will be devoted to railroads.

C. A. McCune, secretary of the Magnaflux Corporation, New York, is general chairman of the convention. On Sunday, October 17, President Gibson will give an informal reception to members of the society.

THE SIXTEENTH INTERNATIONAL PHYSIOLOGICAL CONGRESS

THE sixteenth International Physiological Congress will be held at Zurich from August 14 to 18, 1938, under the presidency of Professor W. R. Hess, of the University of Zurich. Members of the Swiss National Committee are: I. Abelin, Bern; L. Asher, Bern; F. Battelli, Geneva; E. Bürgi, Bern; Ch. Dhéré, Fribourg; S. Edlbacher, Basle; H. Fischer, Zurich; B. Flaschenträger, Zurich; A. Fleisch, Lausanne; W. Frei, Zurich; W. R. Hess, Zurich; P. Karrer, Zurich; M. Minkowski, Zurich; A. v. Muralt, Bern; E. Rothlin, Basle; J. Strohl, Zurich; F. Verzár, Basle. The general secretary of the congress is E. Rothlin, Basle, and R. Speich, of the Swiss Bank Corporation, Basle, is treasurer. The congress will meet in six sections as follows: General and comparative physiology, Biophysics, Biochemistry, Applied physiology (work, sport, aviation), Psychophysiology and Pharmacology.

The sixteenth meeting marks the fiftieth anniversary of the International Physiological Congress. According to the official statement:

> The fact that this congress is being held in Switzerland, the country in which its first meeting was held, affords an excellent opportunity to honor the founders of the International Physiological Congress by devoting special attention to the original objects they had in view and in the spirit with which they were imbued. Wherefore, due regard being had to the changed circumstances of the present day, it is desired in simple outward setting to emphasize the importance of *demonstration* and *discussion* of problems of mutual interest, and more especially to further personal contact between those taking part therein. In addition each member, especially the younger generation of scientists, is to be given the opportunity to introduce himself to his colleagues by an individual communication.

All members of physiological, biochemical, experimental pathological and pharmacological institutes or laboratories are entitled to participate. Those who are not members of any recognized society or institute must be recommended by the director of a recognized laboratory or institute or by the president of a recognized society. The subscription will be 35 Swiss frs, and should be forwarded by check or postal order (Account V 5) payable to the sixteenth International Congress of Physiology, Swiss Bank Corporation, Basle, Switzerland.

There will be the usual entertainments and excursions during the congress. Afterwards a survey of the physiology of high altitudes will be given at the Jungfraujoch High Alpine Research Station. Those interested should communicate with the president, Professor A. von Muralt, 5, Buhlplatz, Bern, Switzerland.

Before the congress an international meeting for cell research will be held at Zurich from August 7 to 13, under the presidency of Professor von Moellendorff, of the Anatomical Institute, Zurich, and the International Veterinary Congress will follow from August 21 to 25, under the presidency of Professor Flückiger, director of the Swiss Federal Veterinary Department at Bern.

SCIENTIFIC NOTES AND NEWS

ON the occasion of the dedication of the new chemistry building at the University of Delaware on October 15 and 16 honorary degrees will be conferred on Dr. The Svedberg, professor of chemistry at the University of Upsala; on Professor Frank C. Whitmore, dean of the School of Chemistry and Physics at the Pennsylvania State College and president of the American Chemical Society, and on Dr. Warren K. Lewis, professor of chemical engineering at the Massachusetts Institute of Technology.

AMONG the honorary degrees conferred on October 14 at the sesquicentennial of Franklin and Marshall College were the following: the doctorate of laws on Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, and on Dr. Harry Woodburn Chase, chancellor of New York University, and the

doctorate of science on Dr. Claude Schaefer Beck, associate professor of surgery in the School of Medicine of Western Reserve University, and on Dr. Karl Musser Houser, professor of otolaryngology in the School of Medicine of the University of Pennsylvania.

AT the celebration of the four hundredth anniversary of the foundation of St. Mary's College of the University of St. Andrews, the doctorate of laws was conferred on Dr. G. F. Stout, professor emeritus of logic and metaphysics in the university and formerly editor of *Mind*, and on Sir C. Leonard Wooley, director of the joint expedition to Mesopotamia of the British Museum and the University of Pennsylvania.

THE honorary doctorate of the University of Zurich has been conferred on Dr. Emil Abderhalden, professor of physiology at the University of Halle.

THE patrons medal of the Royal Geographical Society, London, will be conferred at the annual meeting on October 18 on Lincoln Ellsworth, the explorer, in recognition of his work "in developing the technique of aerial navigation in the polar regions, culminating in his successful flight across the Antarctic in 1935–36." The award is made each year to an explorer of other than British nationality. Mr. Ellsworth sailed for England on October 8.

AT a meeting held in June to celebrate the twenty-fifth anniversary of the founding of the Gesellschaft für Pflanzenzüchtung in Vienna, Dr. George H. Shull, professor of botany and genetics at Princeton University, was elected an honorary member of the society.

THE Benjamin Ide Wheeler Medal, bestowed biennially upon a citizen of Berkeley, Calif., for distinguished public service, was presented under the auspices of the Service Club Council of Berkeley, in connection with a meeting of the Rotary Club on October 6, to Professor William B. Herms, chairman of the division of entomology and parasitology of the University of California. Professor Charles Gilman Hyde, of the university, stated the reasons for the award to Professor Herms, and the formal presentation of the medal was made by Dr. Monroe E. Deutsch, vice-president and provost of the university and chairman of the Board of Award. The award was first granted in 1929, in commemoration of Dr. Benjamin Ide Wheeler, formerly president of the University of California, who died in 1927.

PROFESSOR GEO. A. DEAN, head of the department of entomology, and Dr. R. K. Nabours, head of the department of zoology, of the Kansas State College of Agriculture and Applied Science, Manhattan, were honored on October 1 and 2 at a joint celebration upon the completion of 25 years as chairmen of their departments. Dr. H. B. Hungerford, head of the department of entomology at the University of Kansas, gave the opening address at a special meeting of the Zoology-Entomology Seminar on October 1, on "Interesting Aspects of World Distribution of Aquatic Hemiptera." Dr. Paul S. Welch, member of the entomological staff at the college from 1913 to 1918, now professor of zoology at the University of Michigan, gave an illustrated address in the evening on "The Oxygen Balance in Inland Waters and the Hazards of Aquatic Respiration." The two departments held "open house" on Saturday afternoon, displaying the major accomplishments of twenty-five years and the research work now in progress. A special issue of the Kansas State College *Bulletin* (Vol. 21, No. 9, p. 55) giving biographies of Professors Nabours and Dean, a survey of the accomplishments and titles of all published papers from the two departments in the twenty-five years, was distributed at the banquet. A bound volume of letters from students and friends also was presented to each of them.

DR. HARVEY N. DAVIS, president of the Stevens Institute of Technology, has been nominated president for 1938 of the American Society of Mechanical Engineers.

AT the recent meeting in Boston of the American Society of Civil Engineers, Henry E. Riggs, honorary professor of engineering at the University of Michigan, was nominated for the presidency.

SIR THOMAS HOLLAND, principal of the University of Edinburgh, has been elected president of the Geographical Association of Great Britain for 1938.

DR. WILLIAM R. LONGLEY, Richard M. Colgate professor of mathematics, has been appointed acting dean of Yale University, following the retirement of Professor Clarence W. Mendell.

DR. W. H. STEVENSON, vice-director of the Agricultural Experiment Station of the Iowa State College, has become acting head of the department of agronomy, vacant by the death of Dr. P. E. Brown.

GEORGE BELL, of the U. S. Army, formerly head of the work in animal husbandry of the Bureau of Animal Industry of the U. S. Department of Agriculture, has been appointed a member of the staff of the Kellogg Institute of Animal Husbandry of the University of California.

DR. CARL OLSON, JR., assistant professor of pathology and bacteriology in the New York State Veterinary College, has been appointed research professor in veterinary science at the Massachusetts Experiment Station. He plans to work mainly on poultry problems.

DR. MERIT SCOTT has been promoted to an associate professorship of physics at the Pennsylvania State College.

DR. ROBERT M. ZINGG has been made associate professor in the department of anthropology at the University of Denver.

PROMOTIONS at the Rensselaer Polytechnic Institute at Troy, N. Y., include: *From associate professor to professor,* George H. Carragan and Stanley B. Wiltse, of the department of electrical engineering and physics, and Guy M. Phelps, in charge of drawing courses. *From assistant professor to associate professor,* Harold B. Howe, drawing courses. *From instructor to assistant professor,* William H. Rauscher, chemical engineering and chemistry, and Lynn L. Merrill, Dennis B. Ames and Ralph E. Huston, mathematics.

BERNHARD H. LANE, editor of the U. S. Geological Survey, retired on September 30, after serving on the editorial staff for more than thirty-two years.

ASSISTANT PROFESSOR A. S. HOUSEHOLDER, of Washburn College, who has been awarded a Rockefeller fellowship, will spend the coming year at the University of Chicago working with Professor Nicolas Rashevsky in mathematical biophysics.

S. E. MCCOLL, director of provincial surveys, has been appointed representative for Manitoba on the Canadian National Geographic Board, to succeed W. J. Healy, formerly provincial librarian.

DR. WM. P. N. CANAVAN, associate professor of bacteriology at the School of Medicine of the University of Oklahoma, sailed from New York on October 9 for San Juan, P. R. He plans to spend a year at the School of Tropical Medicine of the University of Puerto Rico.

DR. W. RALPH SINGLETON, assistant geneticist at the Connecticut Agricultural Experiment Station at New Haven, has leave of absence for six months to work with Dr. L. J. Stadler, senior geneticist at the station of the U. S. Bureau of Plant Industry at the University of Missouri.

DR. WILBUR A. SAWYER, director of the International Health Division of the Rockefeller Foundation, gave on October 13 a lecture on "The Revelations of Research in Yellow Fever" under the auspices of the New York University Chapter of Sigma Xi.

DR. SEWALL WRIGHT, professor of zoology at the University of Chicago, will lecture on October 25 at the annual joint meeting of the Institute of Medicine of Chicago and the Chicago Society of Internal Medicine. His subject will be "The Hereditary Factor in Abnormal Development."

DR. PETER VAN DE KAMP, director of the Sproul Observatory of Swarthmore College, lectured on October 15 before the Rittenhouse Astronomical Institute at a meeting held at the Franklin Institute. The title of his address was "Our Stellar Neighbors."

DR. C. H. DESCH, superintendent of the metallurgical department of the National Physical Laboratory, will give the Le Chatelier Memorial Lecture of the Chemical Society, London, on October 28.

THE new Edward Martin Biological Laboratory at Swarthmore College, of which Dr. Laurence Irving is director, was dedicated on October 2. Dr. James Rowland Angell, formerly president of Yale University, gave the address.

Two conferences on chemistry and chemical engineering in connection with the dedication of the new chemistry building at the University of Delaware were planned for October 15 and 16. On Friday afternoon addresses were made by Dr. The Svedberg and Dr. Frank C. Whitmore. These were discussed by Dr. E. O. Kraemer, of the du Pont Experiment Station, and Dr. Hugh S. Taylor, professor of chemistry at Princeton University. Speakers at the second conference on Saturday morning include Dr. Warren K. Lewis and Dr. James F. Norris, professor of organic chemistry at the Massachusetts Institute of Technology. The discussions will be by Arthur M. Greene, Jr., dean of the School of Engineering of Princeton University, and James G. Vail, vice-president of the Philadelphia Quartz Company. Dr. Harrison E. Howe, editor of *Industrial and Engineering Chemistry,* will give an address at the dinner on Saturday evening on "Chemistry and the Nation's Business."

THE twentieth annual meeting of the American Dietetic Association will be held at the John Marshall Hotel, Richmond, Va., from October 17 to 23.

THE annual convention of the American Association of Petroleum Geologists will meet in New Orleans from March 16 to 18. Roy Hazzard, Shreveport, has been named chairman of a field trips committee. Other committee chairmen include: C. I. Alexander, Lake Charles, reception committee; C. E. Cook, entertainment; T. R. Eskrigge, New Orleans, transportation; J. E. Lytle, Hattiesburg, Miss., hotels; Donald Goodwill, Jr., of the state department of conservation, golf committee; C. K. Moresi, of the conservation department, publicity, and Professor Steinmayer, finance.

THE seventh International Congress for Entomology, under the presidency of Professor Martini, of Hamburg, will be held in Berlin from August 15 to 20, 1938. The following sections are provided for: *General entomology:* (1) Systematic entomology and

zoogeography, (2) Nomenclature and bibliography, (3) Morphology, physiology, embryology and genetics, (4) Oecology. *Applied entomology:* (1) Medical and veterinary-medical entomology, (2) Apiculture and sericulture, (3) Forest entomology, (4) Agricultural entomology—(*a*) Viticulture and pomiculture, (*b*) Agriculture and olericulture, (*c*) Stored products insects, (*d*) Means and methods for fighting vermin. The Secretary-General of the congress is Professor Dr. Hering, Zoologisches Museum der Universität, Invalidenstrasse 43, Berlin, N 4.

THE eighth annual meeting of the U. S. Institute for Textile Research, Inc., will be held at the Hotel Commodore, New York City, on November 4. In addition to the regular meeting of members in the morning for the presentation of annual reports and the election of directors, there will be an open research conference in the afternoon and a dinner in the evening. It is hoped that at the research conference representatives of other bodies engaged in textile research will report on progress and on future plans. There will also be an opportunity for members to suggest new subjects to the research council of the institute. At the dinner, in addition to the opening address of President Garvan, there will be given a report by Dean Joseph H. Willits and his associates on "Progress of the Survey of Production and Distribution Organization in the Textile Industries," and a report on "Cellulose Analyses," by Dr. Wanda K. Farr, director of research on the chemistry of cellulose at the Chemical Foundation, which is being conducted at the Boyce Thompson Institute for Plant Research.

GABRIELE D'ANNUNZIO has been named president of the Royal Academy at Rome to succeed the late Guglielmo Marconi. Marshal Pietro Badoglio, veteran of the Ethiopian campaign, has been made president of the National Council of Research, also succeeding Marconi. In accepting the appointment Sr. D'Annunzio sent the following message to Mussolini: "Great comrade, head of Italy's combatants, my chief: Knowing my aversion for holding office and having proved it in more peaceful times, you appoint me to-day president of the Italian Academy, as though to bring forth again fifty years of Latin culture and of pure devotion to my Latin fatherland. The new academy welcomes and gathers to it the flower of our genius and our scholarships, embellishing our *alma parens*. From those genii I learned to compose my human doctrine, from those scholars I learned the earliest beginnings and divined the future development of the nobility and richness of the language I speak and write. Thus designated by you, I enter this renowned laboratory whence the most brilliant work surges from the hardest of toil. So, comrade, I press to my faithful breast you, most Italian of heart, most unvanquished of destiny."

LORD NUFFIELD, the automobile manufacturer, has announced a gift of £300,000 to the Radcliffe Infirmary, Oxford, England. He previously had given £150,000 to the hospital. The second donation is in the form of an endowment fund, the income from which is to be devoted to raising the standard of the infirmary. Lord Nuffield's benefactions in the last eleven years amount to about £8,000,000, including a gift of £2,000,000 to the University of Oxford.

THE *Journal* of the American Medical Association states that plans formulated by the alumni council of Tufts Medical Association for the erection of a new medical school building at the New England Medical Center, Boston, have been approved by the trustees. A fund of $2,000,000 will be raised by public appeal among the alumni of the school and the people of New England, to be used for the building and endowment of various professorships and for the creation of a surgical unit at the Boston Dispensary.

A BASE hospital for Navajo and Hopi Indians, built at a cost of $450,000, is expected to be ready for occupancy by November 5 at Fort Defiance, Ariz. There will be private rooms, wards, isolation wards, a maternity unit and a nursery with facilities for fourteen patients. The Navajo-Hopi reservation of 25,000 square miles is the largest of 199 Indian reservations in twenty-two states. It has a total population of about 45,000 Navajos and 3,000 Hopis.

DISCUSSION

CAN WE ABANDON THE VITAMIN ALPHABET?

ONCE upon a time in the days of the Indians and Cartier life with the vitamins was simple. One drank pine needle tea or vitamin C extract to cure his scurvy (or his syphilis) according to Cartier. Then came Magendie with his dog experiments more than a hundred years ago, and vitamin A was born. More than a half century later Forster tried to feed his dogs on salt-free diets and produced typical symptoms of "B" deficiency. Finally the twentieth century arrived with the creation of the term "vitamin" and the use of a few letters to differentiate these essential factors.

The twentieth century is still young, but the average vitamin student is now afflicted with as many alphabetical vitamins as Job was with boils. Vitamin B

has turned to a full-sized swarm. Not only are there subscript numerals to the extent of six or more, but there are filtrate factors, X factors and even cousins of the B swarm that fly around in the world of bacteriology under such names as "Y."

Not alone can B claim the honor for hatching a full-sized swarm, but D is a close rival. The last news indicated that there were about eight D's, and finally, lest we forget, such infants as H and K. When last heard from there were three H's christened by three fond parents. Each of these discoverers seemed quite innocent of the labors of his fellow workers because so far as any one knows these H factors have nothing in common except a name. And in the spirit of true nationalism and in total innocence of the H brood one of the new German books upon vitamins has devoted a whole section to H, including its use in therapy, chemistry and physiology.

Thus far a considerable fraction of nutrition students have not shied at the specter of the vitamin alphabet, because they have worn blinkers to avoid seeing many vitamins beyond the popular ones and those in their own "frog pond." If you inquire about the vitamin requirements of bacteria in the ordinary nutrition laboratory you will probably get a questioning look because Knight's extensive bulletin on "Bacterial Nutrition" remains unknown. If you ask about the nutrition of planaria or insects you will probably be told that it is rather indecent for the nutrition specialist to consider the vitamin needs of such species. Thus far the rat remains the respectable species in the nutrition world, although the lowly chicken is starting to share this popularity. The pigeon, the dog, the guinea pig and the cow are worthy of a little consideration, while a nutrition worker would have to stoop pretty low if he touched a flea or an earthworm. Even an amateurish science built upon the rat and the chicken is going to become too complex before many more years if the nutritionist persists in retaining his vitamin alphabet. But when the nutrition student finally awakens to the need of including all life, both in the plant and animal world, in his science, even he will realize the present method of lettering vitamins must be dropped.

Therefore in the interests of building a broader science of nutrition, is it not better to abandon or at least to change the alphabet to a minor position? As a substitute I suggest a system of numbers to be issued by some such central agency as the League of Nations. When a new vitamin is to be postulated, the discoverer will need only to address a postcard to the central agency. Thus if a specific growth factor is discovered for moose by some nutrition student working in northern Ontario, he will only need address a request to the central agency. By return mail he will be assigned some number such as 1,572 and this will be recorded thenceforth. As specific properties of this number are developed, they also can be recorded and finally the chemical formula can follow the number. This will make it possible for the student of invertebrates to compare his findings with those of the bacteriologist and these in turn correlated with findings upon higher species. Thus a broader science of nutrition becomes possible with the removal of much of the present confusion.

Furthermore, a system of numbers partly solves the problem of the "lost vitamins." In the vast forest of modern literature are some vitamins wandering around under such titles as "Evidence that a third factor exists" or "Some evidence of the existence of a further factor necessary for growth of the rat." Usually the evidence for the existence of such vitamins is just as concrete as it is for "vitamin Q," but such discoveries are in danger of blooming unseen under the underbrush, while the perpetrator of "vitamin Q" finds his discovery listed in the indices of the abstract journals and discussed in the reviews.

Finally, it must always be recognized that the biologist working with animals is the one who will discover the new vitamins and establish techniques for their assay. This work must precede the isolation by the organic chemist. This order of work is inherent and means that there will be a growing accumulation of vitamins awaiting the attention of the chemist as the years pass and the biologist includes more species in his nutrition studies. After the chemist has done his work the biologist must inevitably return to the problems of comparative nutrition and the elimination of numbers that represent the same factor.

C. M. McCAY

LABORATORY OF ANIMAL NUTRITION
CORNELL UNIVERSITY

LEGUMINAL AND AGROSTAL

WILL "leguminal" and "agrostal" serve for much needed words? Similar to the old Roman phrase, "horribili victu mirabili dictu," the polyglot language we speak is more or less a miraculous lingo in its misappropriation of terminology. When that great family Leguminosae, with its 600 genera and 1,200 species, steps out from behind the systematic botanists' corral and long before they reach the farm the common name is shortened to "legumes." The small cereals and the great are all grasses, and yet there remain those of the meadow, pasture, range, and those living by their autonomous efforts which are not cereals.

Major plant divisions all end in "phyta," ecological classes in "phytes" and the plant families with the suffix "aceae." We recognize cereal for grain grasses and ruderal for certain weed populations; would two additional words ending in "al" be permissible? The adoption of a new slang expression is accomplished

easily, but a change in everyday use of terms describing things vital to man's welfare may be far more difficult.

"The tree is known by its fruit" forms, Biblically, the chapter slogan in a well-known book on symbiosis by Fred, Baldwin and McCoy in which they expend considerable effort to justify the use of the term "leguminous plant." Other exact writers have done similarly, until it appears generally as the common usage only by meticulous portrayers of the Leguminosae.

The terms "tree plant," "bacteria plant" and "legume plant" are not used extensively. Since "legume" is derived from the Latin "legumen" and is the correct name for the fruit or carpel only, *leguminal* is not a far call nor a supernatural one. Already we have "legumin," a vegetable casein, and "leguminous," referring to plants which produce legumes. The new word is no longer nor is it more difficult to pronounce. These many, very valuable plants which have become so well known and called by the same name which by all rights of priority and correct usage belongs to their fruit only certainly deserve greater respect and a more suitable name.

The two new words would complete a set of four very usable terms in forage or "herbage" (British) activity—leguminal, agrostal, cereal, ruderal. We would then propose definitions as follows: Plants producing legumes; grasses other than cereals; grain producing grasses; range and meadow weeds. Leguminosae and Gramineae are the two greatest plant families both in numbers as well as in value to man. Does it not appear a linguistic weakness to confuse important and valuable plant material of such immense proportion further—need the issue be beclouded longer?

Graminal includes all grasses, as does Poaceae, but "agrostal" has not yet been assigned. An agrostologist is a grass specialist; then special grasses, other than cereals, might be *agrostal* in character. "Herbal" is an anciently used qualifying word relating to all plants, just as "herbage" is the name for forage of varying classification botanically.

W. B. GERNERT

OKLAHOMA EXPERIMENT STATION

REID ON CELTIS

IN a short paper[1] describing the endocarps of a new species of Celtis from the Eocene of Réals in Hérault, France, the author states: "These endocarps mark the first known appearance of Celtis in Europe. It has been recorded from the Fort-Union (Eocene) Beds of America."

[1] E. M. Reid, *Bull. Soc. Et. Sci. Nat. Béziers*, 40: 1–8, 1936.

Fossil leaves attributed to Celtis, of which more than a dozen species have been described from many horizons in the European Tertiary, have long been known, some as early as 1850. If one chooses to ignore leaf records there are still several recorded occurrences of fruits. I have two specimens of endocarps labeled as having come from the middle Eocene at Pierrerne, Hérault, which are not dissimilar from the new species described by Reid and also much like *Celtis hyperionis* Unger described from the Miocene of Steinheim. Fruits have also been recorded from several Pleistocene localities in Europe.

If we return to America and ignore the leaf records of Celtis which range in age from the late Cretaceous to the Pleistocene, there are about ten different species based upon endocarps and found at Eocene, Oligocene, Miocene, Pliocene and Pleistocene horizons. Eastern Asia has furnished both leaves and fruits of Tertiary species of Celtis. In 1924 I described a characteristic endocarp from the middle Eocene of Colombia, South America, and leaves are common in the mid-Tertiary of Patagonia.

Mrs. Reid certainly stands out as one of the world leaders in her knowledge of carpological fossil material, and it is a great pity that she does not think it worth while to acquire some slight acquaintance with the literature of paleobotany.

EDWARD W. BERRY

THE USE OF YEAST OR OTHER FUNGI FOR VITAMIN B_1 TESTS

THE suggestion originally made by the writer[1] in 1919, and almost simultaneously by Bachmann,[2] that a fungus organism (yeast) could be used in testing for "vitamin B" has been revived in recent years by suggested quantitative tests for vitamin B_1, using yeast[3] and Phycomyces.[4]

It was shown in the writer's laboratory in 1930[5] that the crystalline vitamin B_1 of Jansen and Donath had a tremendous influence on the growth of certain yeasts, and hundreds of unpublished and published[6] experiments in our laboratory have since confirmed this observation. However, at that time (1930), it was also shown that *another fraction not possessing high vitamin B_1 activity was twice as potent as the purified vitamin* so far as yeast growth stimulation was concerned. In

[1] R. J. Williams, *Jour. Biol. Chem.*, 38: 465, 1919.
[2] F. M. Bachmann, *Jour. Biol. Chem.*, 39: 235, 1919.
[3] A. Schultz, L. Atkin and C. N. Frey, *Jour. Amer. Chem. Soc.*, 59: 948, 1937.
[4] W. H. Schopfer and A. Jung, Ve Congrès International Technique et Chimique des Industries Agricoles. Schéveningue. 1937. Extrait des *Comptes Rendus*, p. 22.
[5] R. J. Williams and R. R. Roehm, *Jour. Biol. Chem.*, 87: 581, 1930.
[6] R. J. Williams and D. H. Saunders, *Biochem. Jour.*, 28: 1887, 1934.

view of this fact, which may have been overlooked, and also because of the complicating effects of pantothenic acid and other nutrilities in tissue extracts, the use of fungi in quantitative testing for vitamin B_1 in extracts appears hazardous in the extreme. At the time the writer's first suggestion was made the current conceptions regarding the chemistry of the vitamins were exceedingly primitive, and the suggestion, even though it did not turn out to be directly usable, was nevertheless of some value as provocative of thought and experimentation. The writer believes that the observations referred to, which form the basis of the proposed tests for vitamin B_1, are interesting and important scientifically but that their value as the basis of quantitative tests is questionable.

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FIRST RECORD OF THE BLACK WIDOW SPIDER IN MINNESOTA

DURING the past several years numerous records have been published on the occurrence of the black widow spider in the United States. While generally regarded as a distinctive southern species it had been reported from every state in the Union except Minnesota. Numerous unsuccessful attempts had been made to collect it in this state, and we can now add definite record of its occurrence here.

On May 21 and 22, 1937, the black widow spider was collected in southeastern Minnesota, in the southern portion of Houston County, a few miles north of the Iowa state line and across the Mississippi River from Wisconsin. Three female specimens were taken, at points several miles from one another. All were found on the sun-exposed sides of hills, where they had built an irregular web under a protruding stone. One specimen was sent to Professor R. V. Chamberlain, who determined it as *Latrodectus mactans texanus*.

A method by which the black widow spider may become further distributed is shown in the finding of a female *Latrodectus mactans* at Hallock, Minnesota, the specimen having been carried from Mississippi in a truck-load of bee-hives.

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SCIENTIFIC BOOKS

FOREL

August Forel. Out of My Life and Work. Translated by BERNARD MIALL. W. W. Norton and Company, New York. Pp. 352. 1937.

FOR fifty years past we have known of Forel as one of the great leaders in entomology, specializing in ants, which he studied from all parts of the world, describing over three thousand new forms. We have known of his patient investigations of the life histories and habits of ants, and from various sources have come intimations of his unique personality. We have been told how he was led, by his experiences as physician to those mentally deranged, to take up the fight against the use of alcoholic drinks, so that people in the opposing camp nicknamed him "The Great Phylloxera." We have heard how he condemned the false standards and evil practices connected with sex, and spoke of these things in any company with a frankness which in earlier days was considered shocking.

When I was a young man, having incipient tuberculosis, I seriously contemplated residence in Switzerland. Circumstances decided otherwise, but I got so far as to read about Switzerland, and for a time almost lived there in imagination. It is curious to think how different my life would have been, had I adopted Switzerland as my country. Although well content to be an American, I have never lost my sentimental regard for that little European country, which combines so much of physical beauty with such a diversity of folks, living peacefully in a genuine republic. At all events, I have missed something by not living in Switzerland; I might have been one of the friends of Forel.

Forel was born in 1858 and died in 1931. Toward the end of his life he decided that he could best tell his own story, neither undervaluing nor overvaluing himself. He felt that he had made many friends and enemies, through his advocacy of reforms, and regretted that some might be offended by his narration. Yet, "I can not get out of my own skin, nor do I wish to." As a matter of fact the book is extremely frank in its statements of facts and its estimates of people, including Forel's nearest relatives. The reader naturally can not say whether all the judgments are sound, but the impression gained is that of a most lovable and entirely sincere personality. He describes in considerable detail his attitude toward religion, which in due course of time led him to reject Christianity altogether. Near the end of his life he adopted the world-religion of the Baha'i, which had its origin in Persia. It was between his fifth and eighth years that he began to study ants. "The social life of these insects had a great fascination for me. I did not as yet understand their habits, but I saw how they helped one another, and how they crept into their nests; and I became extremely curious as to the contents of the latter."

When he was about eleven years old his grandmother came to him and said: "Just think, I once had a dancing partner who was a great lover of ants. He always scolded me when I destroyed the creatures, which used to eat my candied fruits; he was such a kind man and such a lover of animals. He gave me his book; I never finished reading it, but it is said to be a work of great scientific value. Here, take it, but be careful of it and never torment the little creatures again as you have done hitherto." The book was that of the celebrated Pierre Huber, published at Geneva in 1810. Says Forel: "In a flash all the mysteries of ant life, which had hitherto been enigmas to me, were revealed. Huber's book literally became my Bible, and I swore that I would one day become his successor as the historian of the ants." From this time on, in all the possible interludes in an excessively busy life, he studied, collected and described ants. Wherever he might be, if he had half an hour or half a day to spare, it was always possible to look for ants, and actually many new kinds were found in this almost accidental way. Quite early in his career, he published his "Ants of Switzerland" ("Les Fourmis de la Suisse," 1874, 447 pp.), a work which at once established his entomological reputation. He sent a copy to Charles Darwin, who wrote him "a long, very interesting and appreciative letter." Darwin regretted that he could not for the moment send any work of his own, but he sent Belt's "Naturalist in Nicaragua," asking at the same time, "Do you read English easily?" He was much ashamed to have to confess that he did not read English at all, and was spurred by Darwin's words to take up the study of that language so that in time he was able to read the whole of Belt's book and even to speak English after a fashion. "For this Darwin was responsible, and I have been grateful to him all my life."

Like several other distinguished naturalists, Forel took up the study of medicine because it promised a scientific career. He entered as a medical student at Zurich, but at the same time enthusiastically continued his work on ants. He thus attracted the attention of Professor Oswald Heer, who was a very able entomologist and botanist, especially known to-day for his work on fossil insects. Many years ago, when I visited Zurich, I found Heer's fossil insects all preserved as he left them, some with his manuscript names. Although he published much, he left much unpublished work, which no one, to this day, has been able to complete. Heer exerted a strong influence on Forel and persuaded him to write his account of the Swiss ants. On the medical side, Forel was attracted to psychiatry, and did some important work on the anatomy of the brain. He became assistant to Professor Gudden in Munich, and while there succeeded in making such improvements in the microtome that he made the first thin microscopic section of the human brain. In this way, he was able to see clearly structures which had before been described only in vague and confusing terms, and became, in a manner, the teacher of the professor under whom he served. In 1879 Forel took charge of the Cantonal Asylum at Burghölzli, where he remained until 1898. In this period of nearly twenty years he developed his professional skill and matured his ideas about many subjects. At the outset he found the institution in the most deplorable condition, and it required extraordinary courage and persistence to cope with the many difficulties. In 1883 he was married to Emma Steinheil, and of this he says: "Now there was an end of my troubles, and the icy winter in my heart gave way to radiant spr g." Madame Forel soon became a force in the asylum and supplied the kind of influence which was so much needed in the campaign for humanizing the treatment of the insane. Forel's experience as director of the asylum led him to think about the underlying causes of mental breakdown, and while he fully recognizes the force of heredity and the impossibility of curing various types of insanity, he also found that many cases could be cured, and was sure that very many would never have developed under proper conditions. Thus the problem of alcoholic drinks was forced upon him, and both he and his wife became total abstainers and did everything possible to persuade others to follow their example. When I visited Switzerland nearly thirty years ago, I drank the alcohol-free wine which could be obtained anywhere, and heard of the great success of resorts offering no alcoholic drinks, something which greatly astonished those to whom alcohol had long seemed a sort of necessity. All this influence radiated from Forel and his wife, and it would be difficult to exaggerate its significance. During the same period, Forel took up hypnotism, and of this there is much to tell. Eventually, he felt that his work was becoming too complex and too burdensome, and decided to retire from the asylum. He writes of this: "Free! Free at last! That was my first sigh of relief. I had done with my asylum duties, with the government councillors and the supervisory commission, with my courses of lectures, with all my burdensome anxieties; and now I was free to settle down in a little country village near my former home, where I could quietly cultivate my garden. This had always been my longing; now it was gratified." This freedom did indeed enable him to travel about, but as for settling down to cultivate his garden and forget the troubles of the world, that was an impossibility. He was now a leading figure in certain reform movements, especially those having to do with alcohol and sex. Everywhere he was in demand for lectures, and

he always responded to the limit of his ability. In 1902 he went as far as Russia. "We were given a magnificent reception by the Mayor of Moscow, Prince Galitzin, and conducted through all the prisons and institutes of the city. He then invited all the guests to a supper, when the Tsar's health was drunk on champagne. To the horror of Frau von Wolfring, I did not join in drinking the toast, since there was no water on the table! . . . Moscow was at that time a curious mixture of barbarism and culture, with striking contrasts between wealth and poverty, education and ignorance, integrity and corruption, feasting and starvation. And everywhere society was fermenting under the surface."

In 1910, Forel suffered a great blow in the death of his oldest son Eduard, who had just passed his medical examination, and was thought of as the one to continue and develop the great traditions of his father's work. Two years later, just as he was preparing to go on a long voyage to tropical Asia, Forel suffered a stroke, which seemed at first to threaten total disability. He partially recovered, and went on with his studies of ants. The great war of 1914–1919 stirred him up to new activities, in the cause of peace and better social conditions. Forel's matured political faith is eloquently stated by him as follows (written in 1920):

"Socialism is now inevitable, and the social work of 1919 and the following years was, as we see, foretold by Lange. A strong capitalistic, monarchistic and militaristic reaction could only lead to international anarchy and fresh wars, which might indeed delay the final, international social reform by a few decades, but could never, never prevent its final victory. One must be really hidebound and crazy not to see this today, after such infinite ruin, after such an aimless shedding of blood. The modern technique of intercourse, almost unknown a century ago, has to-day made the World Federation of Peoples not only possible, but inevitable. But this will *quite automatically* abolish wars between states, which without it have grown constantly more extensive. Modern warfare is war waged *ad absurdum. This, in a few words, is my political and social testament.* Predatory, egoistic and hypocritical though human nature may be in itself by inheritance, yet it can be tamed from childhood upwards *by social education.* My perception of this I owe in the first place to Pierre Huber—that is, to the study of the ants; then to the study of the dead and living brain of men and animals; then to psychiatry, hypnotism, psychotherapy and medical psychology; further, to Darwin and Semon, and at last, but not least, to my dear wife, and to abstinence from alcohol, to speak only of persons and studies and activities which have had the profoundest influence on my career."

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SPECIAL ARTICLES

PURIFICATION OF TRAUMATIN, A PLANT WOUND HORMONE

ONE of the classical problems of botany is that presented by the "wound hormone," a concept first proposed by Wiesner[1] and later elaborated upon by Haberlandt[2] and others.[3] From the experimental evidence which has accumulated it may safely be concluded that when a plant tissue is injured, a substance or substances are produced which are capable, under suitable circumstances, of inducing renewed growth and division of other, uninjured, mature parenchymatous cells. That this hormone is necessary for the successful cultivation *in vitro* of some plant tissues has also been demonstrated.[4] It may, in addition, play a rôle in such processes as the healing of wounds, callus formation and adventive embryony.[2] In investigations which will be reported in detail elsewhere the present authors have undertaken a chemical and physiological study of such a "wound hormone."

A quantitative physiological assay for wound hormone was developed upon the basis of Wehnelt's[5] discovery that the parenchymatous tissue lining the seed chambers of immature string bean pods reacts to the application of a drop of tissue extract with the formation of a cylindrical "neoplasm" or intumescence. The new growth is the product of simultaneous cell division and cell enlargement. As a measure of activity the present authors have used (a) the concentration of wound hormone needed to produce an intumescence of a definite, relatively large size, and (b) the minimum concentration of active extract which gives a measurable response.

It has been found that the "bean test" is specific for the wound hormone in question. Other substances, such as hetero-auxin, pantothenic acid, etc., cause a response only if they are used in toxic concentrations which cause injury to, and the liberation of hormone from, the test cells themselves.

Using this quantitative assay to work out and to

[1] J. Wiesner, "Elementarstructur," Wien, 1892.
[2] G. Haberlandt, *Beitr. allg. Bot.*, 2: 1, 1921; *Biol. Zent.*, 42: 145, 1922.
[3] H. Reiche, *Zeit. f. Bot.*, 16: 241, 1924; A. Wilhelm, *Jahrb. wiss. Bot.*, 72: 203, 1930.
[4] J. Bonner, *Proc. Nat. Acad. Sci.*, 22: 476, 1936.
[5] B. Wehnelt, *Jahrb. wiss. Bot.*, 66: 773, 1927.

ck each step, a procedure for the purification of the und hormone has been developed. This procedure volves: (1) Extraction from dried bean pods with ohol; (2) adsorption of the active fraction on char- l and elution with pyridine; (3) fractional pre- itation of impurities from pyridine with ether; (4) traction of the hormone with ethyl acetate; (5) con- rsion of the active principle to its barium salt;) precipitation of the active principle with mercuric etate; (7) extraction of the hormone with acetone;) formation of the methyl ester; (9) fractional dis- lation of the ester under high vacuum and subse- ent hydrolysis of the redistilled ester to regenerate e active free acid.

Products of constant activity and identical composi- on have been obtained from three separate large-scale tractions. The ester product of 9 seems to be not r from pure, although it has not yet yielded a single ystalline derivative. A few of its properties will erefore be reported here in a preliminary form. he products of 7 and of 9 (hydrolyzed) possess the me activity in the "bean test" and give a measurable sponse at a dilution of 1:100,000. The "free acid" 7 is a water soluble, extremely hygroscopic, colored, morphous solid. The ester is a yellow oil, readily luble in ether, chloroform, etc., but nearly insoluble water. Its analysis and molecular weight agree pproximately with the formula $C_{11}H_{17}O_4N$, includ- g one methyl group introduced during the esterifica- on. Other evidence indicates that hydroxyl groups e absent and that a second carboxyl group is present a betaine, inner amide or a lactone, of which the rst seems the most likely. The wound hormone ob- ined here is thus clearly different from that concen- ated by Umrath and Soltys[6] from alfalfa. Only mall amounts of ester have as yet been available, and rther extractions upon a larger scale are necessary firmly establish its purity and structure.

The authors propose the name "traumatin" for is principle which is active in the bean test. This ame seems particularly appropriate in view of the wound hormone" historical background of the sub- ance which has been isolated.

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ALGAE AND GROWTH-SUBSTANCES

THIS is a preliminary report of the effect of certain rowth-substances on some unicellular algae.

Since growth-substances affect plant cells in the embryonic state it was deemed desirable to use unicellular algae which reproduce by means of autospores. Young autospores are highly sensitive and respond quickly to stimuli after the manner of embryonic cells. The three algae used were *Chlorella vulgaris, Chlorella pyrenoidosa* and *Oocystis sp.*

A large number of synthetics were employed in growing pure cultures of algae. It was found desirable to exclude sugars and limit the source of carbon to carbon dioxide dissolved in the culture media and carbon in the monobasic acids used.

The synthetic that gave the most satisfactory results had the following formula: potassium nitrate, 1 gr., calcium sulphate, 0.5 gr., magnesium sulphate, 0.5 gr., ferrous phosphate, 0.10 gr., tri-calcium phosphate, 0.25 gr., distilled water 1,000 cc.

It is very important that the correct pH be maintained in all cultures of algae treated with growth-substances. If the acidity or the alkalinity is high the algae are seriously disturbed and lethal action will take place. After many tests it was found that the optimum pH was 5.6–6.5. If the pH were not well buffered at this optimum the readings of the effect of the growth-substances were definitely modified.

The four monobasic acids used as growth-substances were: a-naphthaleneacetic acid, indole-3-acetic acid, indole-3-propionic acid and phenylacetic acid. In the early experiments water solutions of the acids were employed. In later experiments the growth-substances were dissolved in 95 per cent. alcohol—10 mg per cc of alcohol. The alcoholic solution remains unchanged for an indefinite period, whereas water solutions change and give variable results. After adding the alcoholic solution of the growth-substance in various concentrations to test-tubes containing 10 cc of the synthetic the alcohol was removed by autoclaving for 30 minutes at 15 pounds pressure.

The growth-substances were used in concentrations from 1–10,000 to 1–3,000,000. Concentrations from 1–10,000 up to 1–50,000 were lethal for the three species of algae studied. The lower concentrations (1–100,000 up to 1–3,000,000) were positive in their stimulating effect on all cultures compared with the controls. *Chlorella vulgaris* gave affirmative results in from 60 to 72 hours, *Chlorella pyrenoidosa* in from 96 to 120 hours and *Oocystis sp.* in from 150 to 170 hours.

There was some evidence that growth-substances accelerated the rate of cell reproduction and increased the size of cells in the algae studied.

The study of growth-substances on plant tissue has been largely confined to multicellular plants. In those cases there is inevitable masking of the reaction of individual cells to growth substances by neighboring cells. While this difficulty may be obviated, in a mea-

[6] K. Umrath and A. Soltys, *Jahrb. wiss. Bot.*, 84: 276, 1936.

sure, by microchemical technique, it seemed particularly desirable to use unicellular plants in one-celled cultures. Hence unicellular algae were employed in mass cultures in test-tubes, in one-celled cultures in Van Tiegham cells and on agar plates.

A series of quantitative measurements is being compiled and will be published later.

The tests reported in this paper were begun in September, 1935, and have been carried on continuously since that date in the botanical laboratories of the University of Wisconsin. Assistance has been received from the Wisconsin Alumni Research Foundation. I am indebted to Dr. W. P. Zimmerman for the growth-substances used and for helpful suggestions relative to their use with algae.

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TEMPERATURE AND THE GROWTH OF HAIR

CASUAL observation of the variation in the growth of facial hair at different seasons of the year suggested its measurement. An experiment was planned, involving the measurement of the hair shaved from the same part of the face at approximately the same hour and with the same technique every day for one year (the subject, P. E., a florid male, aet. 59).

The crop harvested with one stroke of a straight razor from an area of about one square inch on the right cheek immediately in front of the ear, was washed free from soap, dried and mounted. On each slide selected for measurement one hundred hairs chosen at random were measured with an ocular micrometer. From each month's samples ten were selected for measurement; usually, the first, second and third; the eleventh, twelfth and thirteenth; the twenty-first, twenty-second, twenty-third and twenty-fourth. Each daily value was linked with the average temperature of the preceding day, as furnished by the U. S. Weather Bureau.

Table I gives the average rate of growth and the mean temperature.

TABLE I

Month	Mean temperature	Measured growth
January	58°	.305 mm.
February	54°	.386 "
March	61°	.404 "
April	70°	.458 "
May	74°	.464 "
June	81°	.516 "
July	83°	.533 "
August	82°	.538 "
September	79°	.545 "
October	73°	.533 "
November	64°	.495 "
December	60°	.375 "

A "scatter diagram" constructed from the individual daily measurements shows a very interesting break in the regression line at about 65° Fahrenheit, a temperature which ordinarily calls for heating of homes and office buildings.

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VITAMIN B_1 CRAVING IN RATS[1]

WELL-AUTHENTICATED instances of excessive appetite or craving for special food stuffs are not numerous. We do know that some animals show a marked craving for common salt; other animals show an increased craving for phosphorus, expressed in a desire to eat bones, and some animals, including humans, may have a special appetite for calcium as shown by their ingestion of plaster and chalk. These cravings apparently have their origin in deficiencies produced either by a decreased intake of these minerals, or by an altered mineral metabolism in the case of sodium and calcium craving, dependent on changes in the adrenal[2] and parathyroid[3] glands, respectively.

Another and possibly more powerful craving may now be added to this list: the craving for vitamin B_1. In earlier experiments it was found that normal as well as vitamin B deficient rats show a great appetite for dried baker's yeast, which contains large quantities of vitamin B in addition to many other substances.[4] By virtue of the voluntarily increased ingestion of yeast the animal quickly lost all symptoms of vitamin B deficiency. This is in agreement with observations made by Harris, Clay, Hargreaves and Ward.[5] However, contrary to the results of Harris, *et al.*, we have found that rats show an overwhelming appetite for vitamin B_1 in pure crystalline form, either as B_1 (betaxin or betalin), or Riboflavin. Vitamin B_1 was given in the form of an aqueous solution of synthetic thiamine chloride (betaxin, Winthrop Chemical Company, and betalin, Eli Lilly Company) in graduated inverted bottles. One vitamin deficient rat drank 11 cc, or 5,500 international units, in less than half an hour; another rat drank 29 cc, or 14,500 international units in 24 hours. The odor of the vitamin as well as its taste arouses great interest. This is shown by the fact that the rats found the bottles at once, even when as many as twelve other containers filled with different foods or solutions were present in the cage at the same

[1] From the Psychobiological Laboratory, Henry Phipps Psychiatric Clinic and the Harriet Lane Home for Children, Johns Hopkins Hospital.

[2] C. P. Richter, *Endocrinology*, 20: 657–666, 1936.

[3] C. P. Richter and J. F. Eckert, *Endocrinology*, 21: 50–54, 1937.

[4] C. P. Richter, L. E. Holt, Jr., and B. Barelare, Jr., *Proc. Amer. Physiol. Soc.*, April, 1937, pp. 132–133.

[5] L. R. Harris, Janet Clay, Florence J. Hargreaves and A. Ward, *Proc. Roy. Soc. London*, Series B, 113: 161–190, 1933.

e. It was difficult to stop the animals from drinking the substance, once they had tasted it. Efforts remove the bottle were met with fierce resistance. e bottle was held tightly with both paws and even th the teeth. By reaching far up into the bottles rats made an effort to obtain every remaining drop the vitamin. Riboflavin (lactoflavin), Dimethylrahydroxyamyliso-alloxazin 0.05 per cent. solution, finthrop Chemical Company, elicited a similar, although less marked, craving. Due to the small available amount of the vitamin preparations, it was not termined how long the craving might remain evident. It is of general biological interest that such a powerful craving should be associated with a food stuff of great nutritive importance of vitamin B_1 and that th smell and taste elicit marked responses. The fact that the animals showed an immediate liking for the vitamin indicates that the appetite may not depend entirely on the experience of a beneficial effect resulting from the ingestion of the vitamin. This question of the rôle played by experience and by the deeper biological factors dependent on the taste mechanism we must leave unsettled at present.

The knowledge of the existence of this craving should be helpful for work in animal behavior for use as a reward stimulus. We do not know how general this craving is in different species of animals. In the rat it would seem to be one of the strongest of all the cravings.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD OF MEASURING THE VOLUME OF AMPHIBIAN EMBRYOS

DURING the course of an investigation on the physiogy of development of amphibian embryos, it became ecessary to determine the volume of the eggs. Two cts make accurate determinations of volume by existg methods very difficult: (1) it is impossible to tain accurate wet weights, from which the volume n be calculated after the specific gravity of the eggs s been determined; (2) the early stages burst if ought in contact with the air-water interface. Both ese difficulties are avoided by the method described low.

The present method is an indirect, colorimetric determination and is based on the fact that a known ncentration of material, when made up to different lumes, will give colorimetric readings that vary as e dilution of the solutions. The determinations are ade with the aid of a glass container whose appearce in section and dimensions is shown in Fig. 1. It nsists of a bulb with a narrowed mouth above and pillary entering it below. The purpose of the capilry is to permit the removal of the contents without aving large air bubbles in contact with the eggs. The tal volume of the container is about 4 cc. Before ing used, the container is filled with water and a ference mark is made on the capillary at the upper vel of the water in it when the bulb is in a vertical osition. In the container shown in the figure this was 5 mm from the upper end. Thereafter, when the ntainer is filled with fluid, the level in the capillary adjusted to the reference mark, and thus the same olume of fluid is used in every experiment.

To make a determination the container is filled with ater, the height of the fluid in the capillary adjusted, nd the open end of the capillary sealed with a piece

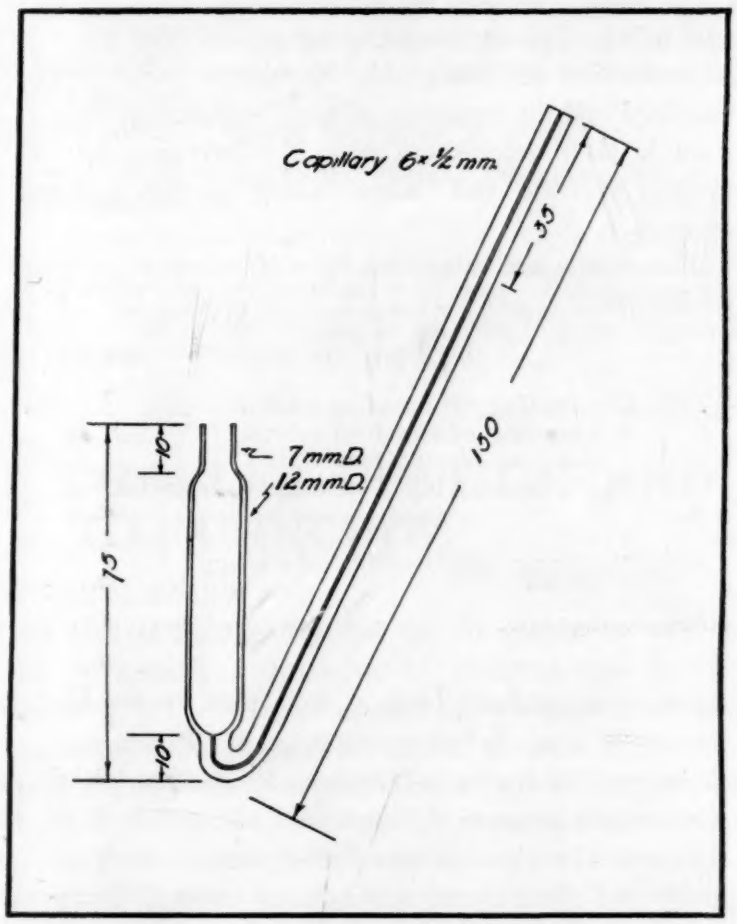

FIG. 1

of Scotch tape. It is important that the seal be airtight, otherwise the embryos may be drawn into the capillary during subsequent manipulation. The container is then immersed in a beaker of water, and the embryos, which have been removed from their membranes, are introduced into the bulb by means of a pipette. In this way they are never in contact with the surface film. Enough embryos are used to make up a volume of about 1 cc. This number varies from 200 *Rana pipiens* and 75 *Amblystoma punctatum* embryos

in the tail bud stage to 75 and 35, respectively, in the feeding stage. The container is then taken out of the beaker, and most of the water removed by pipette, care being taken not to lower the level so much as to bring the animals in contact with the surface film. A convenient amount, usually 2.5 cc, of hemoglobin solution (1 cc of blood diluted to 2 liters with water) is added to the container with the animals and then sufficient water added to bring the fluid level up to the top of the narrowed neck of the bulb. A microburette is used to measure the hemoglobin solution. The Scotch tape is removed and a length of rubber tubing with a mouthpiece is connected to the open end of the capillary. The container is then inverted over a small beaker and the contents expelled by air pressure through the capillary. This prevents bubbling, and with a little practice the embryos can be removed from the bulb without injury, even in open neural plate stages. A standard solution is then made by repeating the procedure without the embryos, the additional volume being of course made up by water. The relative concentration of hemoglobin in aliquot parts of the standard and the unknown solution containing the animals is then determined with a colorimeter by the method of Bing and Baker,[1] using Bing's[2] modified reagent.

The results are calculated by a colorimeter formula as follows:

$$\frac{U}{S} \times V = V_1$$

U = reading of unknown solution
S = reading of standard solution
V = volume of container
V_1 = volume of liquid in unknown solution

and

$$\frac{V - V_1}{\text{Number of eggs used}} = \text{volume of one egg}$$

The advantage of the indirect method is that the actual concentration of reference substance in the standard solution is of no consequence. The greatest source of error is in the reading of the colorimeter. It is possible that a reference substance with a blue color might improve the accuracy. However, tests of this method on known volumes of mercury with hemoglobin as the reference substance showed it to be accurate to within 5 per cent.

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[1] F. C. Bing and R. W. Baker, *Jour. Biol. Chem.*, 92: 589–600, 1931.
[2] F. C. Bing, *Jour. Biol. Chem.*, 95: 387–388, 1932.

THE CULTIVATION OF VIRUSES ON TH CHORIOALLANTOIC MEMBRANES OF CHICK EMBRYOS

During the studies of the cultivation of the virus of Myxamatosis of rabbits and Vaccinia on the chor allantoic membranes of chick embryos, modificatio of the technique as described by Woodruff and Goo pasture[1] were used. A stand for holding the eg which was found superior to those made of plastice was devised by one of us (Elizabeth Osterman). was made by soldering the bowl of an ordinary te spoon on a piece of iron pipe, 1½ inches high and inches in diameter. This is easily cleaned and ster ized as well as being heavy enough to hold the e steadily during inoculation.

The eggs were inoculated under a hood free of currents and kept dust free by a continuously stea ing pan of water. It was not necessary, therefore, place the eggs in warm water during inoculation.

A grinder, known as the Handee Grinder, man factured by the Chicago Wheel and Manufacturi Company, to which had been fitted a ½ inch Carboru dum dental disk was found most efficient for openi the eggs. This has three advantages: first, that t disk can be easily sterilized by immersion in alcoh between operations; second, by use of it the numb of eggs which can be opened in one hour is large increased; and third, the cost ($10.25 for the disk a drill) is much less than a dental drill.

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[1] A. Woodruff and E. W. Goodpasture, *Am. Jour. Pat* 7: 209–222, 1931.

BOOKS RECEIVED

Carlson, Anton J. and Victor Johnson. *The Machi ery of the Body.* Pp. xvii + 580. 187 figures. Un versity of Chicago Press. $4.00.

Fraser, C. McLean. *Hydroids of the Pacific Coast Canada and the United States.* Pp. 207. 44 plate University of Toronto Press. $2.50.

Gray, George W. *The Advancing Front of Science.* P xiii + 364. Whittlesey House, McGraw-Hill. $3.00.

Menninger, Karl A. *The Human Mind.* Revised ed tion. Pp. xiii + 487 + xiii. Knopf. $5.00.

Pidduck, F. B. *Lectures on the Mathematical Theory Electricity.* Pp. viii + 110. Illustrated. Oxford Un versity Press. $3.25.

Webb, Hanor A. and Robert O. Beauchamp. *Workboo in General Science.* Pp. 312. Appleton-Centur $0.88.

Whiteford, G. H. and R. G. Coffin. *Essentials of Co lege Chemistry.* Pp. 514. 32 figures. Mosby. $4.0